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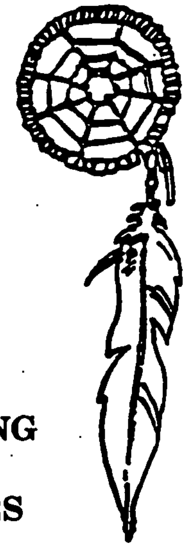
ABSTRACT

This paper documents a culturally specific language strength for developing number sense among Oneida- and Lakota-speaking primary students. Qualitative research methods scaffolded this research study: culture informants were interviewed and interviews were transcribed and coded for analysis; culture documents were selected for analysis; and culture informants served as consultants, validating accuracy, during the writing process. Of all U.S. ethnic groups, Native Americans have the smallest percentage of secondary and postsecondary students performing at advanced levels of mathematics. This limited participation and poor performance in mathematics can be traced to the loss of Native languages through generations of forced assimilation in boarding schools and difficulties among primary students in constructing and using multidigit concepts in English. American children in general demonstrate limited proficiency in foundational concepts of number. One reason may be that for English number-words, place-value meaning is implicit rather than explicit. In contrast, Asian languages such as Japanese and Korean explicitly name number place-values, and children that speak these languages have outperformed U.S. children in assessments of base-10 understanding. Analysis of Oneida and Lakota number-words and interviews with Oneida and Lakota speakers about the linguistic structure of number revealed that like Asian languages, Oneida and Lakota describe base-10 number quantities explicitly. Teaching Oneida and Lakota primary students in their native languages as well as English would help them to develop better number sense. Contains 31 references. Includes numbers vocabulary in Oneida and Lakota. (SV)



INVESTIGATING THE ADVANTAGES OF CONSTRUCTING MULTIDIGIT NUMERATION UNDERSTANDING THROUGH ONEIDA AND LAKOTA NATIVE LANGUAGES

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Statement of the Research Problem

The research question that focused this study was, Will an investigation of the linguistic structure of Oneida and Lakota language number systems reveal an explicitly communicated base ten number structure? Two hypotheses grounded the proposal: 1). that the native languages of Oneida and Lakota are more multidigit, base 10, concept specific than English, and 2). that primary grade Oneida and Lakota students would develop better number sense if they were taught in their native languages as well as English. The proposal of this study is motivated by the fact that Native Americans have the smallest percentage of secondary and post-secondary students performing at the advanced level of mathematics of all U.S. ethnic groups (Hillibrandt, Romano, Stang & Charleston, 1992).

A Brief Review of Related Literature and Research

> If you spoke Oneida you were punished . . . . I remember sitting in the sewing room . . . only three, four, five years old . . . [If you spoke Oneida] you had to knit. [That sister] cut a heel out of a sock, and she made me mend that sock. Plus, I've been hit with a ruler like this (slapping the back of her hand). She would hit. . . . It was a hardship, really hard.
>
> An 82 year old Oneida elder (Hankes, 1994)

> They wouldn't let you talk, you know, your own language. . . . There was always somebody there to see if you spoke Oneida, and if they caught you, they made you stand on a stool and watch the others eat. And you only had so much time that you could be in the dining area, twenty minutes at most, and when they got through eating, you marched out too with your plate still there, but you can't touch it. You walk out of there with an empty stomach.
>
> An 86 year old Oneida elder (Hankes, 1994)

The memories described above, though seemingly unrelated to the concept of multidigit numeration, impact directly upon this investigation. Before considering the study topic, it is important to reflect upon how forced assimilation throughout the nineteenth and twentieth centuries influenced Native American people. Young children taken from their families, stripped of their customs, forbidden to speak their language, passively withdrew within the hostile environments of Bureau of Indian Affairs boarding schools and missionary domiciles. They never became part of the system. They rejected the ways of the "white man's school" and their rejection sustained them, but only partially. They never became what they might have become, powerful keepers of the earth.

But today, at the century's end, tribes across the nation have asserted their rights to educate their children and language and culture emersion schools are increasing in number. For this reason, the present investigation into the explicit communication of multidigit numeration of Oneida and Lakota language is timely. It is also a prudent investigation when reflecting on the mathematics performance of Native Americans discussed in the following section.

Documentation of the Indian Mathematics Problem

Poor performance and limited participation in mathematics by Native Americans of all ages has been well documented throughout the nation (Cajete, 1988; Preston, 1991; Hadfield, 1992). In a paper prepared for a mathematics equity conference, Johnson (1982) reported that while 30.3% of all white students nationally take six or more semesters of math in grades ten through twelve, only 10.9% of all Indians did so. This compares to 17.3 of all Hispanic students and 19.4% of all black students. A comprehensive study completed in 1983 indicated that American Indians were 1.7 years behind the national norm in grade six mathematics achievement and three years behind the norm at grade twelve, and the proportion of Indian students with special needs increased from 32% in grade two to

41% in grade four and 46% in grade six (Fletcher, 1983).

Another study with Ute students in northeastern Utah (Leap, 1988) helps illuminate how limited mathematics proficiency among primary and secondary Indian students impacts on Indian people in general. Leap concluded that poor mathematics performance extends beyond ineffective problem solving to affective domains as well. He found that Indian children who remain in school (as many as 80% of students on Indian reservations do not complete high school (Fries, 1987)) tended to avoid enrolling in mathematics courses or in other courses where mathematics held a significant role in course content. Career choices were also made along similar lines with Ute students rejecting careers that emphasized the need for quantitative skills and favoring career options where qualitative skills were stressed. Consequently, virtually no member of the Northern Ute tribe had been educated in mathematics related sciences, in engineering, in energy-related science, or in business management. It is important to note that this situation is common among tribes across the nation and has serious implications for economic self-determination as well as political self-sufficiency for all American Indians (Lane, 1988). Leap concluded his report with the following comment:

> Perhaps it is now clear why the Indian mathematics problem continues to be a source of major concern for all Indian educators, and even when the problem is recognized, truly effective remediation strategies have yet to emerge (Leap, 1982: pg. 185).

As indicated above, a considerable amount of research has documented the Indian mathematics problem and its consequences; however, few studies have focused on the cause and resolution of the problem (Cheek, 1983; Scott, 1983; Fletcher, 1983). Among the limited studies contributing to this critical discourse are investigations into the influence of low expectations for Indian students held by teachers, counselors, principals (Green et al., 1978), and parents (Ortiz-Franco, 1981); investigations into the impact of equity and opportunity and the influence of low socioeconomic status on performance (Witthun, 1984); investigations into cognition and learning style aspects (Lombardi, 1970; Jordan, Tharp, 1979; Rhodes, 1989; Tharp 1994) and investigations into social-cultural influences (Guilmet, 1979; Phillips, 1982; Greenbaum, 1983; Ericksen & Mohatt, 1988; Leap, 1988; Spanos, 1988).

It is anticipated that the findings of this study will contribute to this critical discourse by documenting a culturally specific language strength that has not been previously identified as unique to Native American (specifically Lakota and Oneida) language patterns and mathematics instruction. It is proposed that by building on this strength, the development of number sense of primary age Lakota and Oneida children will be enhanced.

English Linguistic and Cultural Disadvantages in Constructing and Using Multidigit

Conceptual Structures

The preceding section documented the limited mathematical proficiency of Native Americans; however, Americans in general, and for the purposes of this study, American children specifically, demonstrate limited proficiency in foundational concepts of number. The National Assessment of Educational Progress reported: only 64% of third graders could identify the tens place in a four digit number and less than half identified the hundreds or thousands place; a third of the third graders did not correctly complete two-digit subtraction problems requiring a trade and only half did the three-digit problem correctly; and only 72% of the seventh graders correctly gave the number that is 100 more than 498 (Brown et al., 1989; Kouba et al., 1988). In a study completed in the Chicago area, only 69% of the fifth graders solved correctly a three digit subtraction problem requiring two trades (Stigler, Lee, & Stevenson, 1990). Other studies documented multidigit confusion: many third graders align numbers on the left instead of their positional values when adding and subtracting (Labinowicz, 1985); many third graders identify the 1 traded over to the tens or hundreds column in a regrouping problem as one and not as a ten or a hundred (Labinowicz, 1985; Silvern, 1989);

Fuson (1992) proposes multiple reasons why children in the United States have difficulty constructing concepts of multidigit numeration. One relates to instruction - that most instruction is textbook-driven, and most textbooks present multidigit numeration, addition, and subtraction in ways that interfere with children's ability to make generalizations for developing base ten number sense. Another, relates to the fact that there are few opportunities for children in the United States to work with multiunits based on ten, whereas, almost all countries of the world use the metric system. A third reason relates to the linguistic structure of number words - Fuson states that in English number words, value meaning is implicit rather than explicit:

> Translating between written marks and spoken words is complicated by two differences between the marks and words. First, the values of the spoken words are explicitly named, but the values of the marks are implicit within the positions. Thus, children hearing "five hundred sixty-two" want to write the named values "five hundred" and then "sixty" and then "two" (500602) rather than write what looks like "five six two" (562). Second, the position of the written marks do not have absolute values like those in the named value-words, but have only relative values with respect to the rightmost position. . . . English-speaking children, therefore, need to construct and use multiunit conceptual structures that enable them to understand the differing features of both named-value English number words and positional base-ten written marks, and allow them to relate these two symbol systems to each other.

Comparison of English and Asian based number systems reveals that Asian languages explicitly name number values (12 is "ten two", 58 is "five ten eight", etc.) and explicitly state sums and differences to addition and subtraction problems (8 + 4 is "two ten" not "twelve", an English connotation that communicates a unitary cardinal or sequence meaning rather than a base ten quantity). The impact of explicit meaning to application is documented in studies comparing U.S. and Asian performance on base ten assessment. Multidigit items on written and interview tasks given to a large sample of first and fifth graders in the U.S., Japan, and Taiwan indicated considerably lower scores by U.S. children at both grades (Stigler, Lee, & Stevenson, 1990), and Korean second and third graders explained the trading for tens and hundreds better and calculated more accurately than U.S. third graders (Fuson & Kwon, in press; Song & Ginsburg, 1987).

The present study investigated the common linguistic structure of Lakota and Oneida number words to document the explicit communication of base-ten meaning, explicit communication similar to the Asian system described above.

Investigation Methodology

Qualitative Analysis

Qualitative research methods scaffolded this research study: culture informants were interviewed and interviews were transcribed and coded for analysis; culture documents were selected and coded for analysis; and culture informants served as consultants, validating accuracy, during the writing process.

Study Objectives

1. to review and analyze translations of Oneida and Lakota numbers words to determine the mathematical structure;

2. to audiotape, transcribe, and analyze interviews with Oneida and Lakota language speakers to document the linguistic structure of number within these languages;

3. To develop a document that can be used by primary grade teachers of Oneida and Lakota children to be used when reclaiming language and teaching base

ten number concepts.

Study Findings: Lakota and Oneida Languages and Explicit Multidigit Number Meaning

Like Asian language, Lakota and Oneida languages describes base ten number quantities explicitly. The following translations reveal this commonality:

Lakota

The following number translations were taken from a document developed by Lydia Whirlwind Soldier for the Todd County School District, Mission, South Dakota.

Numbers 1 - 10:

wanci - 1	sakpe - 6
nunpa - 2	sakowin - 7
yamni - 3	saglogan - 8
topa - 4	napcinyunka - 9
zaptan - 5	wikcemna - 10

Counting from 11 - 19

Wikcemna (10) is used to represent ten in all other numbers except the numbers between 11 - 19. Within these numbers, the word *ake* indicates that it will be a number between ten and 20 (*ake* stands for 10 +).

ake wanji (10 + 1)	ake sakpe (10 + 6)
ake nunpa (10 + 2)	ake sakowin (10 + 7)
ake yamni (10 + 3)	ake saglogan (10 + 8)
ake topa (10 + 4)	ake napciyunka (10 + 9)
ake zaptan (10 + 5)	

Larger Numbers

In all other numbers above 19, *wikcemna* (10) is expressed and stands for ten times (10 x __). Also, in numbers larger than the teens, the word *sam* (pronounced sum) is used as +.

wikcemna nunpa (10 X 2 = 20)

wikcemna nunpa sam wanji (10 X 2 + 1 = 21)

wikcemna yamni sam nunpa (10 X 3 + 2 = 32)

Hundreds

Opawinge means hundred times (100 x __):

opawinge wanji sam wanji (100 X 1 + 1) = 101

opawinge wanji sam nunpa (100 X 1 + 2) = 102

opawinge nunpa (100 X 2) = 200

Oneida

The following translations were taken from a vocabulary resource developed by Maria Hinton and Amos Christjohn for theOneida Language Project, Oneida, Wisconsin.

Numbers 1 - 10:

uskah	- 1	ya.yahk	- 6
teken	- 2	tsya.tak	- 7
ahs^	- 3	teklu?	- 8
kaye	- 4	wa.tlu?	- 9
wisk	- 5	oye.li	- 10

Numbers between 11 - 19:

Within these numbers, the *li* ending of the word *oye. li* (10) changes to *le*. The word *yaw^.* is used as plus (+).

uskah yaw^. le	(1 + 10)	ya.yahk yaw^. Le	(6 + 10)
tekni yaw^. le	(2 + 10)	tsya.ak yaw^. le	(7 + 10)
ahs^ yaw^. le	(3 + 10)	teklu? yaw^. le	(8 + 10)
kaye yaw^. le	(4 + 10)	wa.tlu? yaw^. le	(9 + 10)
wisk yaw^ . le	(5 + 10)		

Numbers between 20 - 99

*Wash^* (^ pronounced as uh) is used to represent ten in all number words between 20 - 99. The word *ni* is used to indicate multiplication of tens.

te wash^	twenty		
ahs^ niwash^	(3 x 10)	tsya . tak niwash^	(7 x 10)
kaye niwash^	(4 x 10)	teklu? niwash^	(8 x 10)
wisk niwash^	(5 x 10)	wa . tlu? tiwash^	(9 x 10)
ya . yahk niwash^	(6 x 10)		

Examples of whole numbers greater than 20 and less than 100, excluding multiples of 10:

kaye niwasha wisk [(4 x 10) + 5] - 45

wisk niwasha teken [(5 x 10) + 2] - 52

teklu? niwasha wa tlu [(8 x 10) + 9] - 89

Hundreds:

Tew nya we signifies hundreds; o*k* representing +, examples:

uskah tew nya we - 100

tekni tew nya we ok tewash ahs -[(2 x 100) + (2 x 10) + 2]

Conclusions and Implications

I t is important to reflect again about forced assimilation and the impact of boarding schools on the quantitative performance Indian people. Before Columbus, Lakota and Oneida Indians were adding, subtracting, and multiplying numbers within a base ten system. During the assimilation years, not only was the language of number lost for most Lakota and Oneida people, it was replaced with a system that poorly communicated base ten meaning. Today, in Lakota and Oneida language emersion classrooms, opportunities are being created for students to once again benefit from language explicit communication of base ten concepts.

The information reported in this study has yet to be transferred to curriculum. Once this is complete and students have come to use Oneida and Lakota number words with understanding, future research will determine whether understanding of base ten concepts is achieved more easily.

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